Annual Report to NOAA Climate Program Office, Climate and Societal Interactions, Regional Integrated Science and Assessment

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This performance period covers the fifth year of Award NA11OAR4310141.

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Report Contents

1. NEW AREAS OF FOCUS AND PARTNERSHIPS

ACCAP has established new stakeholder partnerships including expanded collaborations with other boundary organizations to support a coastal hazards and resilience specialist and engagement with Alaska Native communities for climate adaptation. We have also entered new areas of applied climate research, including attribution studies of recent fire season severity and abnormal winter warmth in Alaska.

1.1 Expanded engagement with Alaska Native communities for climate adaptation.

In the last reporting period ACCAP partnered with the Nome Eskimo Community (NEC) and began preliminary steps to outline an approach to develop a climate adaptation plan. Since this partnership, which was initiated by NEC, ACCAP has engaged in several activities to support tribal climate adaptation. Below we update the status of the Nome project and discuss other efforts. Additionally, several tribes have approached ACCAP to assist in the development of climate adaptation plan, including Akiak, Sitka Tribe of Alaska, Central Haida Tlingit. ACCAP will foster emerging partnerships and capacity building opportunities.

1.1.1 Tribal climate adaptation planning in Nome, Alaska.

ACCAP and The Nome Eskimo Community (NEC) are collaborating to develop a tribal climate adaptation plan for the four Nome-based tribes. Project goals are to build climate literacy (familiarity with climate science and local knowledge, provide a forum to discuss climate impacts and adaptation strategies, develop a plan, and share information with other rural Alaska and Native communities. Interviews and workshops have been conducted to identify planning priorities and goals, impacts of concern, and identify climate adaptation strategies. Next steps include prioritizing adaptation strategies, drafting and approving the plan, and presenting the plan to the community.

1.1.2 Best Practices for supporting climate adaptation in Northwest Alaska.

ACCAP is partnering with Glen Gray and Associates and Alaska Sea Grant to identify best practices for supporting climate adaptation in Northwest Alaska. Our analysis is based on 15 interviews with community members involved in two recent coastal climate adaptation planning efforts: Shaktoolik (2014), and Nome (in progress). We are exploring the specific decision and cultural contexts of Northwest Alaska Native communities that must be considered in the design of effective climate adaptation planning efforts, including the role of traditional knowledge,

governance, values, and barriers. Findings from this research will be submitted as a chapter in a book on supporting climate adaptation in rural communities in the US.

1.1.3 *Tribal climate science liaison.*

With leveraged funds from the Bureau of Indian Affairs, ACCAP has partnered with the Aleutian Islands Pribilof Association to support a tribal climate science liaison to improve the capacity of the 229 federally recognized tribes in Alaska for climate adaptation (section 7.1).

1.1.4 *Tribal climate webinar series.*

ACCAP, Water Policy Consulting LLC, and tribal environmental and climate professionals across the country partnered to offer a webinar series on climate adaptation for Alaska Natives. The series discussed how Alaska Native Villages can apply state, federal and tribal policies to address climate impacts on water and subsistence resources through water resource management and protection, land and water rights, and sovereignty. The webinar series consisted of 6 webinars with an average attendance of 30-40 participants per webinar.

1.2 Climate Adaptation.

In addition to our tribal climate adaptation efforts, ACCAP is also involved in other climate adaptation activities.

1.2.1 *Evaluating climate adaptation planning process in Homer, Alaska.*

ACCAP Intern (L. Olsen) is evaluating the 2007 Climate Action Plan in Homer and the recent actions to revisit the plan to increase its relevance. This project seeks to understand the institutional structure of the plan, what actions in the plan have been implemented, barriers and enabling factors, and the shifting interest from mitigation to adaptation. Project findings will be submitted as a case study on NOAA's Climate Resilient Toolbox (June 2016).

1.2.2 *Adaptation Actions for a Changing Arctic*

ACCAP members Walsh and Trainor are contributing lead authors on a report for The Arctic Council, entitled "Adaptation Actions for a Changing Arctic Report, Bering, Chukchi, and Beaufort Region.

1.3 Extreme Events.

The recent extension of ACCAP's climate science research targeted extreme events. ACCAP (Walsh, Lader, Bieniek) participated in an attribution study of the 2015 fire season in Alaska. The area burned during this season was the second largest on record for Alaska. The attribution study drew upon climate model downscaling, the use of the model output to compute an index of landscape flammability, and comparisons of the present climate with a counterfactual (preindustrial) climate without climate change. The primary tools were the Weather Research and Forecasting regional climate model and the NOAA Geophysical Fluid Dynamical Laboratory global climate model. This study was performed in partnership with the National Weather Service and the Alaska Fire Science Consortium.

A second study examined the exceptionally warm Alaska winter of 2015-16. This recent winter and broader cold season (October-April) were the warmest on record in Alaska. This weather, which was also characterized limited snowfall, significantly reduced heating and snow removal costs. The attribution study utilized an analog model developed by B. Brettschneider to determine the portion of the abnormal warmth that was attributable to the atmospheric circulation pattern. The excess warmth, over and above that explained by the wind pattern, was attributed to a combination of abnormal ocean temperature and diminished sea ice conditions in

the waters surrounding Alaska; the effect of the reduced snow cover on the surface energy balance; and the direct but slower radiative effect of increasing greenhouse gas concentrations.

A third study is examining historical and future trends in rain-on-snow (freezing rain) events in Alaska, which can have severe and adverse impacts on transportation, power outages, and food access by wildlife. Led by P. Bieniek, this study is also using regional climate model output to assess the trends. Several stakeholder groups (including ecosystem modelers and wildlife specialists) have requested this information from the dynamical downscaling project, which is collaborative with the USGS-funded Alaska Climate Science Center.

1.4 Evaluating Boundary Organizations.

ACCAP has recently started two evaluations of boundary organizations.

1.4.1 Evaluating science communication in boundary organizations.

In partnership with the Alaska Fire Science Consortium (AFSC), ACCAP is investigating and evaluating the process of communicating climate science and climate-related wildfire impacts to wildfire managers in Alaska. The project investigates the activities and evolution of the boundary organizations and also incorporates assessment of decision-support tools and research co-production. Data collection is complete, including 21 semi-structured interviews with core members of AFSC and ACCAP, Advisory Board members, relevant scientists, and wildfire managers. Interview recordings are currently being transcribed and coded.

1.4.2 Evaluating partnerships between Alaska Natives and Industry.

ACCAP, in partnership with the North Slope Borough (NSB), is evaluating a cooperative agreement between the NSB and Shell Oil (Collaborative Arctic Alaska Studies Program), which was developed to support research on baseline conditions relevant to oil and gas development to help the NSB and Shell inform decision making. Science questions for this research include:

- What factors contribute to effective knowledge co-production in the context of a contentious political environment?
- What actions and activities are most effective in supporting relationship necessary for knowledge co-production?
- What is the role of public-private partnerships in improving information collection and management of issues in the context of contested spaces?

The research builds on a growing body of literature on the processes of making basic science relevant for decision makers, the role of boundary organizations in support of use-inspired knowledge, regionally-specific decision making contexts that impact knowledge co-production, public-private partnerships, and evaluation of knowledge co-production. This research is funded by Alaska EPSCoR the NSB and began May 1, 2016.

1.5 Analysis of Current and Projected Future Economic Effects of Climate Change in Alaska.

Although much has been written about potential physical and ecological effects of climate change in Alaska and their consequences for people, relatively little research has specifically addressed economic effects. ACCAP is partnering with the Institute of Social and Economic Research at the University of Alaska, Anchorage to fill the information gap by describing the potential nature and scope of economic effects of climate change that are likely to become manifest in Alaska over the next 30-50 years. The objective of the study is to synthesize information about what is known and what is not known about the economic effects and to outline what additional research, data collection or information gathering would be necessary to

fill in the unknowns. Effects arising through a broad spectrum of drivers and mechanisms are considered using a common framework and common set of scenarios and assumptions. Order of magnitude quantitative estimates of economic effects will be made in cases where the effects are known and data are available. Primary uncertainties about the nature and magnitude of economic effects, as well as potential data sources and known data gaps are considered.

2. USE OF CLIMATE INFORMATION AND SERVICES IN ALASKA

During this reporting, ACCAP has facilitated the use of climate information and provided technical services to several new entities.

2.1 Climate Adaptation Planning.

ACCAP has facilitated community meetings in Nome to document traditional knowledge and observations of climate-related environmental change, and identify key climate concerns and adaptation strategies. Climate science observations and projections of climate change, specific to the Seward Peninsula (Nome region) were used by community members to understand potential future risks.

2.2 Evaluation of a database as a climate service tool.

In partnership with the Western Alaska Landscape Conservation Cooperative (WALCC) and Northern Pacific Landscape Conservation Cooperative (NPLCC), ACCAP is identifying and synthesize existing research projects in the WALCC region related to physical, biological, and human dimensions of coastal change. In this reporting period we have initiated an evaluation of the coastal change project database that was created in the last reporting period. accap.uaf.edu/W_AK_LCC_Coastal_Change_Research. This evaluation is being conducted by master's student Nicole Warner and involves interviews and surveys with principle investigators included in the database, LCC staff, and potential database users including community planners. Research questions under investigation are:

- How was the WALCC database utilized since its creation and for what purposes?
- What challenges does this database face as a science communication tool in Western Alaska?
- How can this evaluation inform the employment of science communication tools in this region in the future?
- The project is in design phase and interviews are expected to begin June 2016.

Additionally, we have expanded this original partnership to include coastline of the NPLCC focus area within Alaska and Cook Inlet. The goals of this extension are to:

Short term: (1) create a database that compiles current coastal change research occurring in Cook Inlet and South East Alaska, (2) to produce an inviting, accessible report that compiles current coastal change research occurring in the NPLCC, and (3) update existing coastal change project resources for the Western AK LCC.

Long term: (1) to foster better trans-boundary coordination about coastal change research in Cook Inlet and South East Alaska, (2) help practitioners and scholars learn from one another, and (3) identify research gaps that need to be addressed.

3. KEY RESEARCH FINDINGS

We report on our core research findings and outreach activities based on the major areas of focus at ACCAP: climate science, adaptation and boundary science, and planning for climate impacts.

3.1 Climate Science

3.1.1 Climate change and fire.

Alaska experienced its second-worst fire season on record in the summer of 2015, when more than 5 million km2 of forest burned. Climate change in Alaska has increased the likelihood of a fire season of 2015's severity by 30-60%. This increase is relative to the preindustrial period. The increased risk is due primarily to warmer temperatures in the spring and summer. The effect of the warming is partially offset by the increase in precipitation associated with climate change. The major uncertainty in future scenarios of fire activity in Alaska is the lightning frequency, which is not directly output by climate model. A manuscript entitled "An assessment of the role of anthropogenic climate change in the Alaska fire season of 2015" has been submitted for publication.

3.1.2 Climate Variability.

Less than half of the anomalous winter warmth in Alaska during the 2015-2016 is directly attributable to the atmospheric circulation (including effects of El Niño). The largest portion of the remainder appears to have resulted from abnormally warm ocean temperatures south of Alaska, unusually low sea ice coverage west of Alaska, and a deficient snow cover over the land. The latter effect explains the fact that the largest "excess" warmth occurred during the late winter and early spring when more solar radiation is available to be absorbed by the darker surfaces no longer covered by snow as they have been in the past. A manuscript entitled "the exceptionally warm winter of 2015-16 in Alaska: attribution and anticipation" has been submitted for publication.

3.1.3 Sea Ice.

In terms of pan-Arctic sea ice extent, the past decade is unique in the newly compiled pan-Arctic sea ice database. Both the increased rate of retreat and the recent extreme minimum values of extent are unprecedented in the post-1850 data. Decadal and multi-decadal variations do occur regionally, and the Bering Sea's decade of relatively extensive winter ice in the early 2000s is one example. This work is published in Walsh et al. (in press).

3.2 Adaptation and Boundary Science.

ACCAP collaborated with the DOI Alaska Climate Science Center to map the landscape of climate science, services, and decision making in Alaska. 126 interviews were conducted with key individuals involved in climate-related research, services and decision-making in Alaska to understand: (A) the extent that individuals are engaged in mutually exclusive categories of producers and consumers of information versus multiple roles and (B) differences in the level of interaction across the science practice interface. (https://accap.uaf.edu/node/595). A manuscript entitled "
"Collaboration and co-production of climate knowledge: lessons from a network on the front-line" has been submitted for publication.

<u>Key Findings:</u>

- The relatively high level cohesion around a few core climate service providers highlights the potential for efficient information transfer and learning across the network. As the network develops, lower levels of centralization may be more effective in resolving complex management challenges.
- There are some significant differences in the level of interaction among scientists, service providers, and decision makers, which implications for adaptive capacity and success of knowledge to action networks.
- Conceptualizing the science policy interface in terms of mutually exclusive categories of *producers* and consumers of information oversimplifies the roles of people engaged in climate science, services, and decision making. The higher level of connectivity to otherwise disconnected actors among those engaged in the combined role of services and decision maker as well as those engaged in all three roles, suggests that these individuals have greater control over the flow of information and greater potential to connect otherwise disconnected actors.

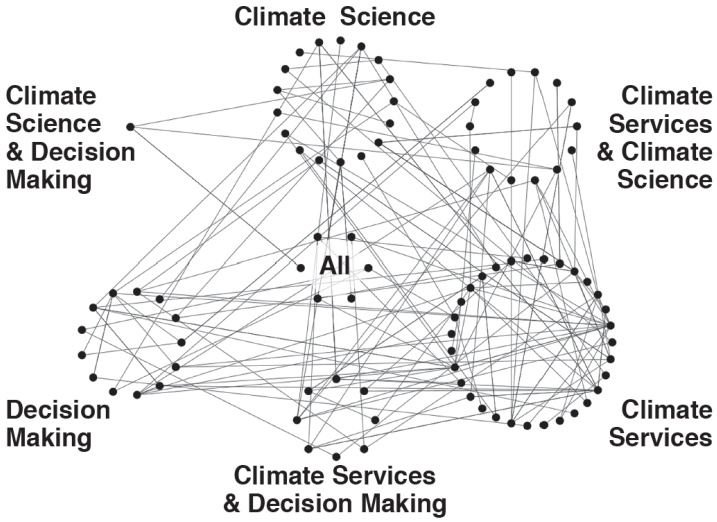


Figure 1

3.3 Planning for climate change impacts on hydropower in the Far North

Unlike much of the contiguous United States, new hydropower development continues in the Far North, where climate models project precipitation will likely increase over the next century. Regional complexities in the Arctic and sub-Arctic, such as glacier recession and permafrost thaw, however, introduce uncertainties about the hydrologic responses to climate change that impact water resource management. This work reviews hydroclimate changes in the Far North and their impacts on hydropower; it provides a template for application of current techniques for prediction and estimating uncertainty, and it describes best practices for integrating science into management and decision-making. The growing number of hydrologic impacts studies suggests that information resulting from climate change science has matured enough that it can and should be integrated into hydropower scoping, design, and management. Continuing to ignore the best-

available information in lieu of status quo planning is likely to prove costly to society in the long term. This work is published in Cherry et al. (2016).

4. ACCAP-SPONSORED RESEARCH

ACCAP provided financial support for research through a new ACCAP mini-grant competition, existing Center for Global Change Student Grant Competition. Below we discuss key research findings from each of these three efforts.

4.1 ACCAP Mini-grant Competition

ACCAP solicited research proposals as part of a mini-grant competition in spring 2015. For each of the selected projects, ACCAP provided summer salary support (one month for faculty or three months for graduate students. Below we discuss the key findings from each of the six funded projects – all of which were required to have significant stakeholder engagement aimed at promoting action-oriented science.

4.1.1 *Informing Fisheries Adaptations to a Changing.*

Terry Johnson, Alaska Sea Grant Marine Advisory Program Agent

Goal: This project produced a summary of the state of knowledge of the effects of climate change on Alaska's commercial fisheries, and offered some ideas about ways that the fishing industry and fisheries-dependent communities could start planning adaptation to coming changes. It was based on extensive literature review coupled with informal interviews with scientists, fishermen and others who had observations concerning climate and Alaska's fisheries.

Key Findings: (1) The Gulf of Alaska and Bering Sea are getting warmer, more "acidic", and sea ice is declining in the Bering Sea; (2) long-term changes in Alaska fish stocks are relatively subtle; responses to inter-annual and decadal climate variability have more profound affects; (3) some important fisheries resources, such as walleye, pollock, and king crab, are likely to decline, and others (like halibut and some salmon stocks) may experience modest increases in abundance by 2050; (4) few adaptive management measures have been identified, beyond increasing research and monitoring. The fishing industry, which is constantly adapting to environmental and economic change, has not yet articulated a strategy for adapting to climate change.

4.1.2 *Improving understanding of ringed and spotted sea ice habitat for resource managers*

Olivia Lee, (funded as a postdoc, currently an Assistant Research Professor)
International Arctic Research Center, University of Alaska Fairbanks (IARC)

Goal: Improve collaborations with the North Slope Borough Department of Wildlife, and federal and state agency biologists to identify additional scale-relevant data that could be used to describe the changing sea ice habitat for spotted and ringed seals.

Key Findings: (1) Ringed seals did not travel beyond the marginal ice zone, but stayed within sea ice concentrations below 60%. (2) Spotted seals travel close to shore in low concentration sea ice or ice-free water during the summer. High resolution Synthetic Aperture Radar data

may be needed to identify the use of ice floes as resting platforms for spotted seals, but this currently requires additional data processing and high costs for daily satellite images.

4.1.3 Improving scientific understanding of the changing hydrologic system of the Jarvis Creek watershed and its impacts on the ecosystem

Anna Liljedahl, Water and Environmental Research Center & IARC, University of Alaska Fairbanks

Goal: to develop a comprehensive understanding of how recent and projected climate warming have and will affect glaciers and permafrost and its cascading effects on the larger-scale hydrologic system of Interior Alaska.

Key Findings: Analysis of long-term historical datasets (weather, glacier melt and runoff) and our field measurements suggest that the increased late winter runoff (baseflow) of the Tanana River during recent decades is most likely linked to glacier melt. This is due to lack of increasing precipitation trends, while summer warmth has increased and glacier coverage decreased. Further, glacier area decrease is larger on the north-facing than south-facing slopes for the Alaska Range. Our continuous differential runoff measurements in summer 2015 confirm that the Jarvis Creek is a losing stream, which supports the baseflow trends observed in the long-term records as the glacier melt feeds the streams, which in turn recharges the groundwater aquifer that ultimately release water to the Tanana River throughout the year.

4.1.4 Blue carbon: the role of marine predators in carbon storage and sequestration

Heidi Pearson, Assistant Professor of Marine Biology, Department of Natural Sciences, University of Alaska Southeast

Goal: to understand how humpback whales and sea otters provide "blue carbon" ecosystem services by stimulating the growth of marine algae in coastal marine ecosystems of Southeast Alaska, ultimately contributing to carbon sequestration.

Key Findings: (1) Sea otters in Sitka Sound have the capacity to affect carbon sequestration. This is due to the trophic cascade effects of sea otters that prey on sea urchins, which in turn releases kelp from grazing pressure and allows kelp forests to flourish, ultimately helping to reduce atmospheric CO2 levels. (2) This project facilitated the development of several regional, national, and international stakeholder interactions and collaborations, which enabled data sharing, analysis, and interpretation, and the development of grant proposals. Project data were used to write a successfully funded grant application for the NSF Coastal SEES program.

4.1.5 Climate-induced changes to trophic interactions of top predators and forage fish species in a sub-Arctic ecosystem

Courtney Pegus, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Goal: To develop a productive research-oriented working relationship with the National Park Service that will be mutually beneficial for the research objectives of this study as well as the long-term monitoring efforts of the NPS. The specific research objectives are to determine if climate-driven changes to glacial ice are related to declines in harbor seal populations in Glacier Bay and to investigate the possibility of inter-specific competition occurring between harbor seals and humpback whales because of reduced glacial ice habitats.

Key Accomplishments: As this funding was used at the very beginning of Courtney's PhD project we report primarily key accomplishments instead of research findings. The ACCAP funding allowed Courtney to make important contacts within the key agencies, primarily NOAA's Alaska Fisheries Science Center Polar Ecosystems Program, that were conducting aerial surveys on several tidewater glaciers throughout Alaska. He obtained several optical images of iceberg habitats from different tidewater glaciers and is analyzing these images using remote sensing techniques. Data collected was used to develop a comparative analysis of iceberg habitats that will be used for the remainder of Courtney's PhD research.

4.1.6 Sustainable Engineering Techniques for Rural and Traditional Arctic Infrastructure

Rorik Peterson, Institute of Northern Engineering, University of Alaska Fairbanks

Goal: Investigate heat storage and loss of the community ice cellar in Kaktovik, Alaska using high-resolution numerical modeling to provide guidance for future monitoring and design, identify the impact of different food storage techniques and identify new hydrothermal infrastructure challenges that can be addressed using novel engineering solutions that utilize sustainable techniques.

Key Findings: (1) Vertical shaft from the building to the cellar can play a significant factor in sensible heat transport. The asymmetry of the shaft placement, the large horizontal span of the cellar, and the existence of the earth pillar in the central all combine to cause the "distant" side of the cellar (opposite the entrance shaft) to be measurably warmer than the rest of the cellar. (2) The optimum thermosiphon placement is actually not radially uniform around the circular cellar as expected and initially designed, but with the thermos-syphons slightly more densely on the opposite side of the entrance building and shaft. (3) Placement of large sensible and latent heat items such as unfrozen meat and/or whale blubber can cause somewhat significant transient thermal effects that can last for over a week.

4.2 Center for Global Change Student Grant Competition

ACCAP contributed to the ongoing student research across the University of Alaska system via supporting two grants (cgc.uaf.edu/student_grant). These projects began in July 2015 and final reports will be submitted soon. The two projects are as follows:

4.2.1 Evaluating behavioral adaptations of subsistence halibut harvesters to environmental and regulatory changes in southeast Alaska

Maggie Chan (UAF PhD student, School of Fisheries and Ocean Sciences)

Goal: This project assesses trends in subsistence Pacific halibut harvest through in-person interviews with resource users in three communities in Southeast Alaska and evaluates the

impacts of the creation of a subsistence halibut sector in 2003, which liberalized bag limits and gear type for subsistence halibut harvest.

4.2.2 How will climate change impact the morphology of the Beaufort Sea coastline?
Louise Farquharson (UAF PhD Student, Geology)

Goal: This project seeks to reconstruct the paleoenvironment along the northern Alaska coast during the Late Pleistocene

5. STAKEHOLDER OUTREACH AND COMMUNICATION ACTIVITIES

5.1 Participation at conferences, workshops, webinars.

ACCAP investigators presented their research, participated in panel discussions, hosted and attended workshops, and chaired sessions in a variety of venues, both within Alaska and on a national level that were attended by Alaska stakeholders:

- Alaska: Alaska Forum on the Environment, Nome Tribal Climate Adaptation Planning workshops, LCC Coastal Resilience Workshops, Landscape Conservation Cooperative Communication Trainings.

- National: Association of American Geographers Annual Meeting, Islanded Communities (Guam), Environmental Protection Agency webinar series, NOAA/Environment Canada Marine Forecasting Workshop, American Geophysical Union Fall Meeting, RISA Annual Meeting

5.2 Social Media.

This year, ACCAP has seen an increase in social media influence, with 623 fans on Facebook (528 last year) and 316 followers on Twitter (238 last year).

5.3 Newsletters.

Published quarterly since 2010 and written for a non-technical audience, the Alaska Climate Dispatch (sections 10.4.1) includes seasonal weather and climate summaries, feature articles on topics of current interest, and Alaska weather, wildfire, and sea ice outlooks.
Published and written for a non-technical audience. The Changing Ice Newsletter highlights projects and discoveries led by Alaskan scientists engaged in cryosphere research.

5.4 Webinars.

ACCAP continues to host two webinar series that are effective in supporting knowledge to action networks and networks among boundary organizations. Additionally we co-hosted a new short-term webinar series (section 1.1.4) focused on climate change and Alaska native communities.

5.4.1 Alaska Climate Webinar Series.

Our flagship webinar series has provided monthly opportunities to promote dialog among scientists, climate service providers, decision makers since 2007. Evaluations of this webinar series highlight the role of remote engagement in supporting knowledge to action networks in Alaska and how partnering with other boundary organizations increases the effectiveness of webinars for ACCAP and partnering organizations. Over 900 people participated in ACCAP Alaska Climate Webinars during this reporting period. In addition to noted scientists from UAF

and other universities across the country and regionally based partners, ACCAP webinars this year featured scientists from federal partners and non-profits, the Pew Charitable Trust and the Cold Climate Housing Research Center. Recorded webinars are available at: http://accap.uaf.edu/webinars.

5.4.2 *NWS Alaska Climate Forecast Briefing.*

In the second year of ACCAP's collaborative webinar series with the NWS, we continue to deliver monthly climate forecast briefings on recent climate conditions around Alaska and predictions for the next month and season. Briefings are well attended with 10-20 people in-person and approximately the same number online. This collaboration is also helping to foster closer connections between NWS, the UAF research community and the broader climate and weather community including the National Park Service and US Army. Additionally, we often have media members in attendance (accap.uaf.edu/NWS_Briefings). This summer, ACCAP is preparing to launch an evaluation of the NWS Alaska Climate Forecast Briefings to better understand our audience and facilitate improvements of the briefings.

5.4.3 *Alaska Policy & Climate Adaptation Webinar Series.*

ACCAP partnered with Water Policy Consulting, LLC to offer the Winter/spring 2015-16 Policy & Climate Adaptation Mitigation and Planning for Alaska Natives webinars series. The series demonstrated how Native Villages and other communities in Alaska could apply state, federal and tribal policies to address climate change impacts on water and subsistence resources through water resource management and protection, land and water rights, sovereignty and other resiliency and mitigation strategies. Over 250 people attended the six webinars in the series.

5.5 Decision Support Tools.

ACCAP maintains several decision support tools, which were developed in collaboration with several federal agencies and academic institutions.

5.5.1 *Climate and Weather Highlights Tool.*

Designed in collaboration with the NWS, the Climate and Weather Highlights Tool provides information about notable historical weather and climate events. Data reported are preliminary observations and are reported in daily, multi-day, monthly, and longer time scales. Users can select date ranges, filter results, click on individual events for further information, and zoom in/out of the map. Events are updated in near real-time. Rick Thoman of the NWS provides the data for this tool and ACCAP provides the online interface that allows stakeholders to access the highlights in a visually appealing and easy to understand manner (https://accap.uaf.edu/?q=tools/climate_highlights).

5.5.2 *Historical Sea Ice Atlas.*

During the past year, in collaboration with the National Snow and Ice Data Center, we completed the compilation of a pan-Arctic sea ice dataset spanning 1850-present. The dataset is a gridded synthesis of information from approximately 15 different sources of sea ice information, ranging from whaling ship reports to more recent passive microwave satellite data. The monthly archive lists sources as well as areas of estimation by interpolation or analog methods. The dataset extends ACCAP's Historical Sea Ice Atlas for Alaska to the pan-Arctic scale, and is described in a recent publication in Geographical Review (Walsh et al., 2016). Development of a user interface for the pan-Arctic database will be undertaken in the first year of ACCAP's newly approved continuation period. In addition to the work on the pan-Arctic database, ACCAP has continued to update the Historical Sea Ice Atlas for Alaska. The most recent update extended to December 31, 2015 and is available at http://seaiceatlas.snap.uaf.edu/

5.6 Artic Science Summit Week (ASSW).

ASSW is an annual gathering of international organizations involved in Arctic research, which is designed to strengthen collaborations across academia, government agencies, local communities, industry, and non-governmental organizations. The 2016 Summit was held in Fairbanks, Alaska, and included ASSW Business Meetings, the Arctic Council Senior Arctic Officials Meeting, the 2016 Arctic Observing Summit, and the first fully developed Model Arctic Council. As part of the free public events held in conjunction with ASSW, ACCAP helped fund and coordinate the "Dark Winter Nights: North Through Our Eyes" live storytelling event and "Arctic Perspectives" art show, which showcased art inspired by the Arctic and research to improve Arctic understanding. Both the art show and the storytelling event are currently being compiled and analyzed.

5.6.1 Dark Winter Nights: "North Through Our Eyes"

The event was an evening of storytelling showcasing stories about observed changes in the North. Over 400 people attended, which allowed ACCAP stakeholders (scientists and community members) to share their experiences related to Arctic change with the general public and ASSW participants. This event was part of the ongoing Dark Winter Nights storytelling series produced by the University of Alaska Fairbanks (professorprince.com/darkwinternights) and the recordings will become part of a larger library of stories about Alaska told by Alaskans. The event served ACCAP's central mission of stakeholder interaction and outreach and served to further connect ACCAP and our stakeholders with the general public as well as the broader Arctic wide research and policy community that was in Fairbanks for ASSW.

5.6.2 The Arctic Perspectives Art Show

The exhibit showcases art inspired by the Arctic and research to improve Arctic understanding. Contributors include researchers and artists from the University of Alaska Fairbanks as well as members of the community. ACCAP funded travel for six pairs of artists and scientists. Artists and scientists were given travel funds to visit one another and various field locations with the goal of facilitating mutual understanding and promote meaningful dialogue on Arctic science. The interaction between artists and scientists can promote understanding and awareness of the scientific basis in the context of Alaska's and the Arctic's changing ecosystems. The art was displayed during the entire week of ASSW and a catalog of the art was produced as a lasting record of the collaboration effort and a valuable resource to show the usefulness of future artist/scientist collaboration efforts. Additionally the catalog is a way of communicating the science and results of the collaboration after the show has ended and the artwork has been distributed and is no longer available for viewing.

6. STUDENT AND POST-DOC MATRICULATION AND RECRUITMENT

ACCAP continues to expand its capacity building efforts by training new generations of scientists engaged in action-oriented science. ACCAP has increased the number of students and early career faculty supported, expanded the types of positions available, and facilitated the advancement of early career scholars.

- Research Associates:
    - Nathan Kettle has advanced from post-doctoral fellow status to research associate at the International Arctic Research Center at UAF. He continues to spearhead boundary science research and climate adaptation. He is now a CO-I on ACCAP's next 5-year grant award and is co-advising ACCAP interns (S. Tangen, L. Olsen).

- Post Doctoral Fellows:
  - Brian Brettschnieder has developed an analog forecast model for application to seasonal sea ice prediction. The model is based on metrics of similarity between the present year's atmospheric state (temperature, pressures, geopotential height, sea surface temperature) and corresponding fields in past years.
  - Melanie Covavito has been recruited to evaluate the process of science co-production and communication of climate information in wildlife management and decision making in Alaska, including the decision contexts of wildfire management in Alaska, organizational frameworks for connecting science with users, innovation of decision-support services and evolution of action-oriented science (section 1.4.1).
  - Josie Sam is a new post-doctoral fellow leading ACCAP's examination of best practices for supporting climate adaptation in Northwest Alaska (section 1.1.2).
  - Norman Shippee is developing applied storminess indicators for Alaska through consultation with stakeholders in the marine shipping community and communities. The goals of this project are to develop targeted storminess indicators and thresholds related to strong wind events for decision makers within the marine sector and integrate these thresholds into a forecast indicator for marine stakeholders (section 7.3).
- Ph.D. Students
  - Katia Kontar's (Interdisciplinary Studies) is investigating how to improve preparedness and response to annual springtime flooding in Alaska, United States and Sakha Republic (Yakutia), Russia through the development of effective and easily adaptable flood risk mitigation and disaster response and recovery strategies.
  - Rick Lader (Atmospheric Sciences) is assessing extreme climate events in dynamical downscaling output for Alaska, based on regional model simulations (section 1.3).
- Master's Students
  - Aurora Roth (Resilience and Adaptation Program) is examining potential future changes to the Juneau Icefield and the consequences of these changes on downstream ecosystems.
  - Nicole Warner (Natural Resource Management) is evaluating the use and usability of the coastal change project database that was created with leveraged funds from the Western Alaska Landscape Conservation Cooperative (WALCC) (section 2.4).
- ACCAP Interns
  - Stefan Tangen (UAF Master's Student in Natural Resources Management) is a Peace Corps Coverdell Fellow examining how cross-level differences in perceptions of adaptation success may be a barrier to climate adaptation in rural villages in Alaska.
  - Lindsay Olsen is evaluating the climate adaptation planning process in Homer Alaska, including the status of climate adaptation planning efforts, implementation of strategies identified in 2007, and barriers and enabling factors.

7. NARRATIVES

ACCAP engaged stakeholders in several manners that resulted in plans, policies, strategies, tools, and agreements that were either proposed or adopted. Below we highlight three examples and discuss the role of ACCAP in contributing to these accomplishments.

7.1 Tribal Climate Science Liaison.

ACCAP contributed to the supporting the development of tribal climate science liaison (3 year position), who's responsibilities are to improve the capacity of the 229 federally recognized tribes in Alaska prepare for and respond to climate change. The liaison will provide extension support, conduct research, and coordinate with other tribal climate science liaisons across the US. Extension support includes the identification of climate science needs, support of climate adaptation planning, and development of links between tribal needs and research capacity. Research includes the identification of best practices for connecting climate science with tribal science needs. This position will be housed in the Alaska Climate Science Center (Anchorage or Fairbanks) and will be funded by the Bureau of Indian Affairs. ACCAP partnered with the Aleutian Island Pribilof Association, the five Alaska Landscape Conservation Cooperatives, UAF Community Partnership for Self-reliance (CPS), Alaska Native Science Commission, and Scenarios Network for Alaska and Arctic Planning to develop the proposal. ACCAP's role in this project is to coordinate entities co-located at the University of Alaska Fairbanks, including ACCAP, CPS, the Alaska Climate Science Center, SNAP, and the International Arctic Research Center for the tribal liaison. ACCAP will also collaborate with the tribal liaison on climate adaptation research, including the analysis of barriers to climate adaptation and assessment of best practices for connecting climate science and tribal science needs to support climate-sensitive decisions and adaptation.

7.2 Coastal Hazards and Resilience.

ACCAP, Alaska Sea Grant, and AOOS collaboratively partnered to hire a Coastal Community Resilience Specialist for Alaska. This position is physically housed with Alaska Sea Grant in Anchorage, as part of the Alaska Sea Grant Marine Advisory Program. The primary responsibilities of this position are to assess and prioritize the community resilience and adaptation needs of coastal Alaska, and design, coordinate, deliver and evaluate programs based on those priorities. Davin Holen, an anthropologist with over a decade of experience in rural Alaska with the Alaska Department of Fish and Game, was hired for this position in January 2016. Davin has advanced several aspects of ACCAPs mission; (1) partnering with ongoing climate adaptation efforts around the state, including supporting the U.S. Fish and Wildlife Service Landscape Conservation Cooperative (LCC) project Promoting Coastal Resilience & Adaptation in Alaska workshops held between May and December 2016 in the Bering Sea communities of Nome, Unalaska, King Salmon, and Kotzebue. Developing a workshop in collaboration with the Sitka Tribe of Alaska and Central Council Tlingit Haida India Association entitled Southeast Alaska Climate Adaptation Planning Summit to be held in Ketchikan in September 2016 with funding from the North Pacific LLC program, and developing a tribal climate adaptation plans in partnership with ACCAP and the Nome Eskimo Community. (2) Collaborating with several Alaska Native Tribal organizations Davin has built relationships with over the years to apply for funds to support new climate adaptation plans including Central Council Tlingit Haida and the Akiak Native Community. (3) Developing projects to conduct coastal community vulnerability indices including one that will be funded fall 2016 entitled

Coastal Community Vulnerability Index and Visualizations of Change in Cook Inlet, Alaska, and working with partners at the National Snow and Ice Data Center to develop applications that could provide climate and weather data to coastal communities with feedback to climate scientists including the proposed project from the NASA ROSES program HARVEST Alaska: Creating a Mobile Application to Enable Rural Alaskans to Collect and Share Critical Data and Observations on Food Security in Alaska.(4) Finally working with existing State of Alaska agencies on citizen science coastal monitoring programs and other outreach activities such as participating in the new Alaska Ocean Acidification Network steering committee activities including website development and organizing a State of the Science workshop which is scheduled for December 2016, and the Alaska Division of Geological and Geophysical Services and University of Alaska Fairbanks led Stakes for Stakeholder: Quantitative Tools and Resources for Community Based Shoreline Erosion Monitoring project.

7.3 Storminess indicators for marine shipping.

ACCAP is partnering with marine shipping communities to understand thresholds for strong wind events and integrate this information into applied storminess forecast indicators and tools for marine stakeholders. Key accomplishments so far include (1) the development of a seasonal storm event and lull event climatology for the circum-Arctic using multiple reanalyzes, including trend analysis, frequency, and indicators of storminess, and (2) establishment of an extended extratropical cyclone climatology for the Gulf of Alaska and Bering Sea back to 1920 from the Twentieth Century Reanalysis (20CR), which allows for a better understanding of how cyclones have changed within the recent past. Information on lull and wind event information was presented and discussed during the shipping season with our Canadian shipping partners, and we anticipate evaluate these same capabilities with the Alaskan companies and a Victoria-based company in the next year.

8. OVERALL PROGRAM IMPACT

8.1 Program-level impact

ACCAP is using a logic model (updated from our 2010 proposal) to guide program assessment planning and program-level impact (Fig.2). This model describes the relationships among the Alaska context, program inputs and resources, activities, outcomes (what is produced), and outcomes (changes that result from the program), which provides the basis for program evaluation. Building on our previous evaluations of the ACCAP Climate Webinar Series (section 4.1.1) and decision support tools (section 4.5), ACCAP is in the process of designing evaluations of our NWS Alaska Climate Forecast Briefing (section 4.1.2).

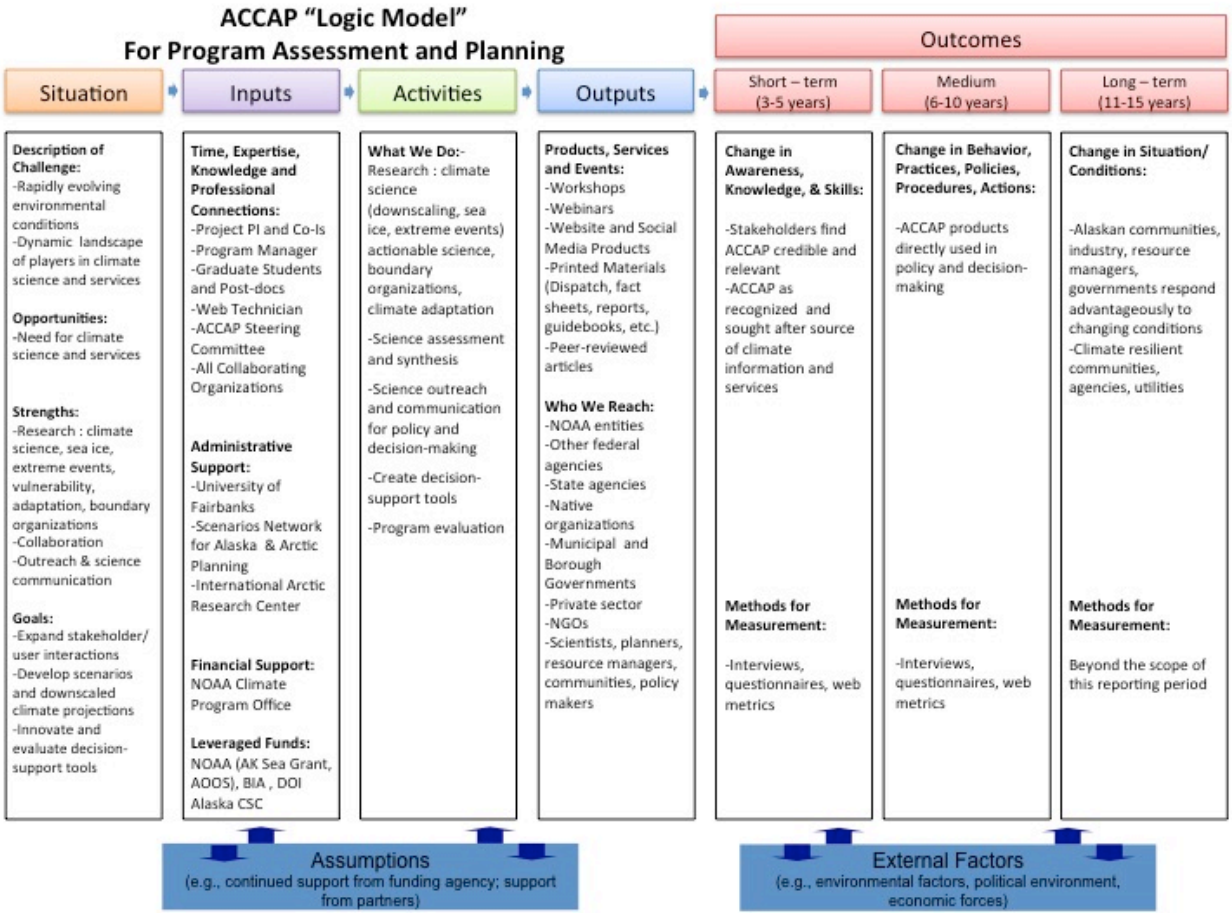
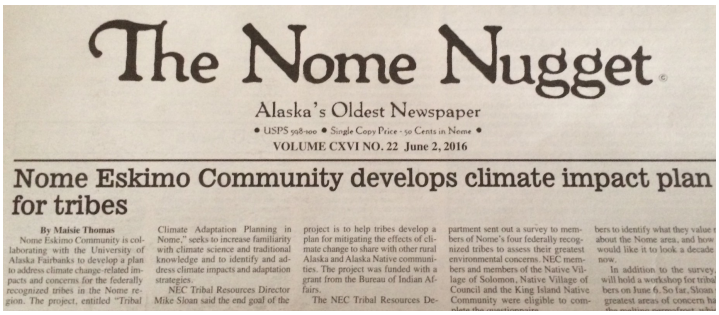


Figure 2

8.2 Building Capacity.

Building capacity of decision makers across Alaska to prepare for and respond to climate variability and change remains a core effort of ACCAP. ACCAP continues to build capacity via: (1) our three different ongoing webinar series that support network building and information exchange (section 5.4); (2) collaborating with the Nome Eskimo Community to develop a tribal climate adaptation plan for the Nome-based tribes (section 1.1.1); (3) coordinating with the Alaska Ocean Observing Network's Alaska Ocean Acidification Network to increase understanding of ocean acidification, identify knowledge gaps and information needs, share best practices for monitoring, and promote data sharing; and partnering with Alaska Sea Grant to support a coastal community resilience specialist; (4) developing storminess indicators with the shipping industry (section 7.3); and (5) supporting a coastal hazards resilience specialist (section 7.1).



The Nome Nugget

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VOLUME CXVI NO. 22 June 2, 2016

Nome Eskimo Community develops climate impact plan for tribes

By Maisie Thomas

Nome Eskimo Community is collaborating with the University of Alaska Fairbanks to develop a plan to address climate change-related impacts and concerns for the federally recognized tribes in the Nome region. The project, entitled "Tribal Climate Adaptation Planning in Nome," seeks to increase familiarity with climate science and traditional knowledge and to identify and address climate impacts and adaptation strategies.

NEC Tribal Resources Director Mike Sloan said the end goal of the project is to help tribes develop a plan for mitigating the effects of climate change to share with other rural Alaska and Alaska Native communities. The project was funded with a grant from the Bureau of Indian Affairs.

The NEC Tribal Resources Department sent out a survey to members of Nome's four federally recognized tribes to assess their greatest environmental concerns. NEC members and members of the Native Village of Solomon, Native Village of Council and the King Island Native Community were eligible to com-

bers to identify what they value about the Nome area, and how would like it to look a decade now.

In addition to the survey will hold a workshop for tribal bers on June 6. So far, Sloan greatest areas of concern ha

Figure 3

8.3 Proud Accomplishment:

Over the past year ACCAP has deepened our engagement with Alaska Native tribes to support climate adaptation, including supporting climate adaptation planning (section 1.1.1); securing funding for a 3-year funded tribal climate science liaison to understand impacts, concerns, and needs, and connect such needs with university researchers, federal and state agencies, and funding sources (section 7.1); supporting a jointly funded Coastal Climate Resilience Specialist that is engaging tribes in translation of climate information and climate adaptation planning (section 7.2); and evaluating Alaska Native-Industry partnerships to support climate adaptation (section 1.4.2). We are proud of these accomplishments because these efforts because:

- Tribal organizations are reaching out to ACCAP for assistance, which demonstrates our increasing level of credibility as a climate service provider in Alaska.
- These efforts contribute to addressing immediate needs for communities that have traditionally been underserved for climate and climate impacts.

9. FIVE KEY PUBLICATIONS

National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change.* [Committee: D. W. Titley, G. Hagerl, K.L. Jacobs, P.W. Mote, C.J. Paciorek, J.M. Shepherd, T.G. Shepherd, A.H. Sobel, **J. Walsh** and F. W. Zwiers]. National Academies of Sciences, doi:10.17226/21852.

Bieniek, P. A., U. S. Bhatt, **J. E. Walsh**, **T. S. Rupp**, J. Zhang, J. R. Krieger and R. **Lader,** 2016: Dynamical downscaling of ERA-Interim temperature and precipitation for Alaska. *J. Appl. Meteor. Climatol.*, 55, 635-654.

Cherry, J.E., **C. Knapp, S.F. Trainor**, A.J. Ray, M. Tedesche, S. Walker. 2016. Planning for climate change impacts on hydropower in the far north. *Hydrology and Earth System Sciences* doi:10.5194/hess-2016-167.

Frisch, L., J. Mathis, N. Kettle, S.F.Trainor. 2015 gauging perceptions of ocean acidification in Alaska. *Marine Policy*. 53:101-110.

Kettle, N. and **S. Trainor**. 2015. The role of remote engagement in supporting boundary chain networks across Alaska *Climate Risk Management.* 9:6-19.

10. ADDITIONAL PUBLICATIONS

ACCAP published several journal articles (n=11), books and book chapters (n=3), other peer-reviewed reports, and non-peer reviewed reports during his reporting period. Below is a

comprehensive list of publications for this reporting period. Bolded authors represent those that are current or former ACCAP team members.

10.1 Peer-reviewed journal articles

Bieniek, P. A., U. S. Bhatt, **J. E. Walsh**, **T. S. Rupp**, J. Zhang, J. R. Krieger and R. **Lader,** 2016: Dynamical downscaling of ERA-Interim temperature and precipitation for Alaska. *Journal of Applied Meteorology and Climatology*, 55, 635-654.

Cherry, J.E., **C. Knapp, S.Trainor**, A.J. Ray, M. Tedesche, S. Walker. 2016. Planning for climate change impacts on hydropower in the far north. *Hydrology and Earth System Sciences* doi:10.5194/hess-2016-167, 2016.

Frisch, L., J. Mathis, N. Kettle, S.F.Trainor. (2015) Gauging perceptions of ocean acidification in Alaska. *Marine Policy*. 53:101-110.

Kettle, N., and K. Dow. 2016. The role of perceived risk, uncertainty, and trust on coastal climate change adaptation planning. *Environment and Behavior*. 48(4): 579-606.

Kettle, N. and **S. Trainor**. 2015. The role of remote engagement in supporting boundary chain networks across Alaska *Climate Risk Management.* 9:6-19.

Kontar, Y. Y., Bhatt, U. S., Lindsey, S. D., Plumb, E. W., and Thoman, R. L., 2015. Interdisciplinary approach to hydrological hazard mitigation and disaster response and effects of climate change on the occurrence of flood severity in central Alaska, *Proceedings of the International Association of Hydrological Sciences:* 369, 13-17.

Knudsen, E.M., and **J.E. Walsh**, 2016: Evaluation of northern hemisphere storminess in the Norwegian Earth System Model. *Geoscientific Model Development*, accepted.

Lader, R., U.S. Bhatt, **J.E. Walsh**, **T. S. Rupp**, and **P.A. Bieniek**, 2016: Two-meter temperature and precipitation from atmospheric reanalysis evaluated for Alaska. *Journal of Applied Meteorology and Climatology*, **55**, 901–922.

Walsh, J.E., F. Fetterer, J.S. Stewart and W.L. Chapman, in press. A database for depicting Arctic sea ice variations back to 1850. *Geographical Review*.

Walsh, J. E., and L. D. Hinzman, 2015: Challenges, opportunities and responsibilities. where will the USA take the Arctic Council? *The Circle*.

Webler, T., S. Tuler, K. Dow., J. Whitehead, **N. Kettle**. 2016. Design and evaluation of a local analytic-deliberative process for climate adaptation planning. *Local Environment*. 21(2): 166-188.

10.2 Book Chapters

Drake, J. L., **Kontar, Y.**, Eichelberger, J. C., **Rupp, T.S**, and Taylor, K. M. (*Eds.*) 2016. *Communicating Climate-Change and Natural Hazard Risk and Cultivating Resilience: Case Studies for a Multi-disciplinary Approach.* Springer. Series: Advances in Natural and Technological Hazards Research, Vol. 45.

Taylor, K., Hum, R., and **Kontar, Y.**, 2016. Comparative analysis of virtual relief networks and communication channels during disaster recovery after a major flood in Galena, Alaska, Spring 2013. In: *Communicating Climate-Change and Natural Hazard Risk and Cultivating Resilience: Case Studies for a Multi-disciplinary Approach.* Springer Series: Advances in Natural and Technological Hazards Research (45): 151-171.

Trainor, S., N. Kettle, and B. Gamble. 2016. Not another webinar! Regional webinars as a platform for climate knowledge to action networking in Alaska. In: Climate in Context. Editors: A. Parris, G. Garfin, K. Dow, R. Meyer, and S. Close. Wiley. pp. 117-142.

10.3 Other peer-reviewed publications

National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change.* [Committee: D. W. Titley, G. Hagerl, K.L. Jacobs, P.W. Mote, C.J. Paciorek, J.M. Shepherd, T.G. Shepherd, A.H. Sobel, **J. Walsh** and F. W. Zwiers]. National Academies of Sciences, doi:10.17226/21852.

10.4 Non-peer reviewed publications

Panda, S, **S.F. Trainor,** Gusmeroli, A, H. Eicken,, Rupp, S. 2015. Changing Ice: A Newsletter of Cryosphere Research in Alaska. (https://accap.uaf.edu/library/newsletters)

Walsh, J.E., S.F. Trainor, and A. York (eds). Alaska Climate Dispatch Quarterly Newsletter. (https://accap.uaf.edu/library/dispatches)

11. ATTACHMENTS/APPENDICES

(All attachments have been optimized and placed in one PDF for digital delivery. Please request higher resolution files for print.)

1. Alaska Climate Dispatch (March 2015)
2. Changing Ice Cryosphere Hazards Newsletter (September 2013)
3. Five key peer–reviewed journal publication listed above.